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Buried Plastic Pipe Doesn't Fail From Pressure

When attempting to establish the long-term performance of plastic piping materials, we try to establish a relationship between pressure and time-to-failure for the material. One way to develop that information is to test pipe extruded from the material and subject specimens of the pipe to various constant pressures and wait until failure occurs. Specimens at higher pressure rupture in shorter periods of time, while those at lower internal pressure take longer times for failure to occur. By plotting the log of hoop stress versus log time-to-failure, a relationship develops which is used in an attempt to establish the long-term performance of the material --- and ultimately the pipe.

The procedures used to establish the working pressure for plastic pipe are generally conservative, and have performed fairly well for the past 50 years, however, the industry still has problems with failures occurring periodically, particularly with buried pipe. One of the reasons is that we tend to forget that buried plastic pipe, that is properly installed, is supported mainly by the strength of the surrounding soil. All buried flexible pipe, including glass-reinforced plastic pipe, gains most of its strength from the stiffness of the soil surrounding the pipe. The structure is analogous to the plastic pipe acting as a liner for a concrete pipe having a wall thickness of several feet thick. The structure is so strong that the internal pressure is directly transferred to the soil, which prohibits any circumferential strain from occurring within the plastic pipe. Stress and strain are directly interrelated --- if there is no strain, there is no stress. Therefore, pressure no longer becomes the driving force for failure in buried plastic pipe.

So what causes failure in buried plastic pipe? Secondary loads, such as impingement, bending, shear, torsion, impact, live loads, deflection loads, third-party damage, etc. create the driving force for failure in buried plastic pressure pipe. Each of these loads creates a certain amount of deflection or strain in the pipe wall. It is the tensile strain caused by secondary loads which drives the failure of the material in service.

One intuitive solution when facing the problem of plastic pipe with increased failures (particularly used in the gas distribution industry) is to lower the internal pressure on the system. The problem is that the internal pressure is actually resisting the deflection caused by secondary loads; therefore, reducing the internal pressure actually enhances the strains created by secondary loads, therein, increasing the likelihood of failure.

Plastic piping engineers should reevaluate their methods of understanding the failure processes of plastic pipe, and consider the interrelationship of stress and strain processes and how the plastic pipe interacts with its surroundings when considering how failures actually occur.

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